

# Observation and Modeling of Antarctic Ice Sheet and Ocean Circulation Interactions.

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## Project Objective:

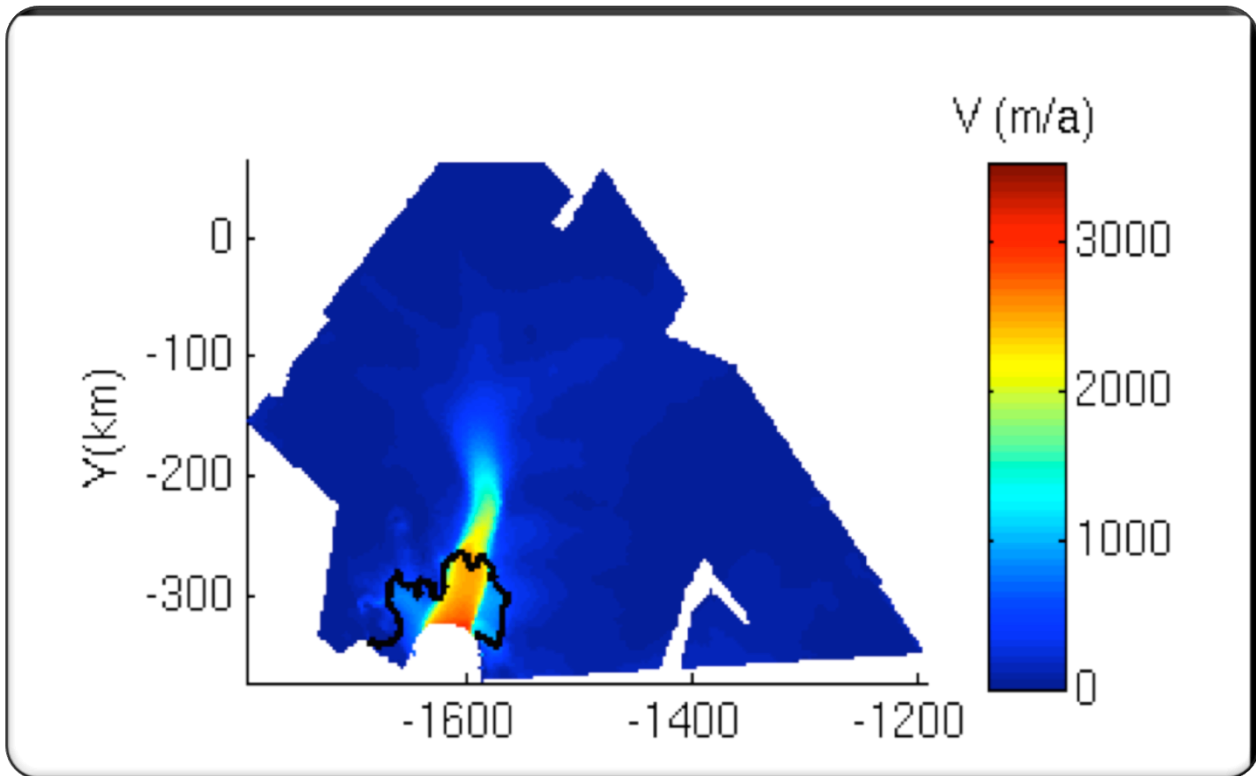
Our objective is to couple the Ice Sheet System Model, a new three-dimensional, high resolution, higher-order model of the Antarctic ice sheet, with the global Ocean, Phase II (ECCO2) project. The coupled model will then be integrated to provide a more realistic description of ice flow in Antarctica, ice shelf cavity melting, and ocean circulation around Antarctica, and to enable the development of sensitivity studies to determine the evolution of the Antarctic ice sheet into a warming climate.

## FY10 Results:

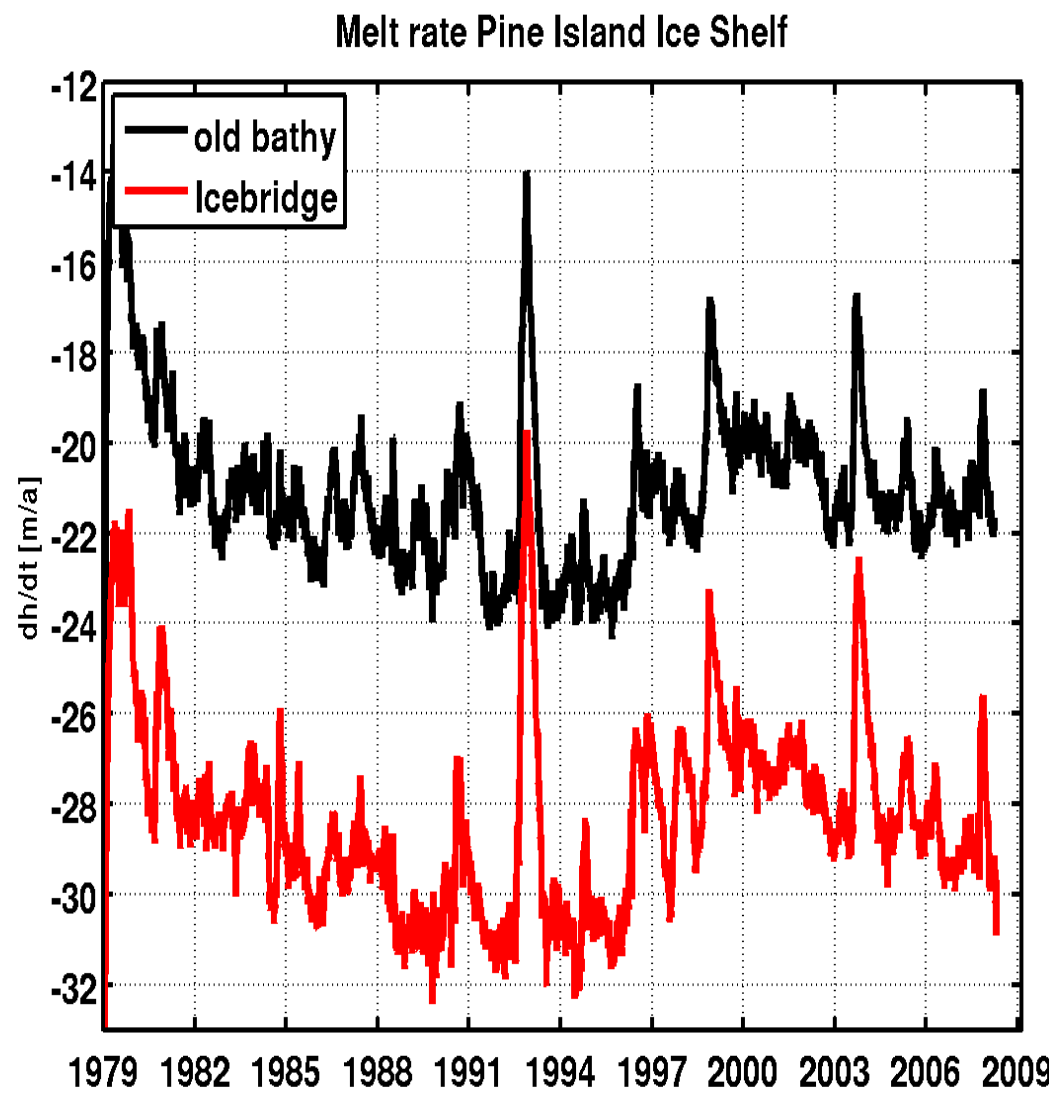
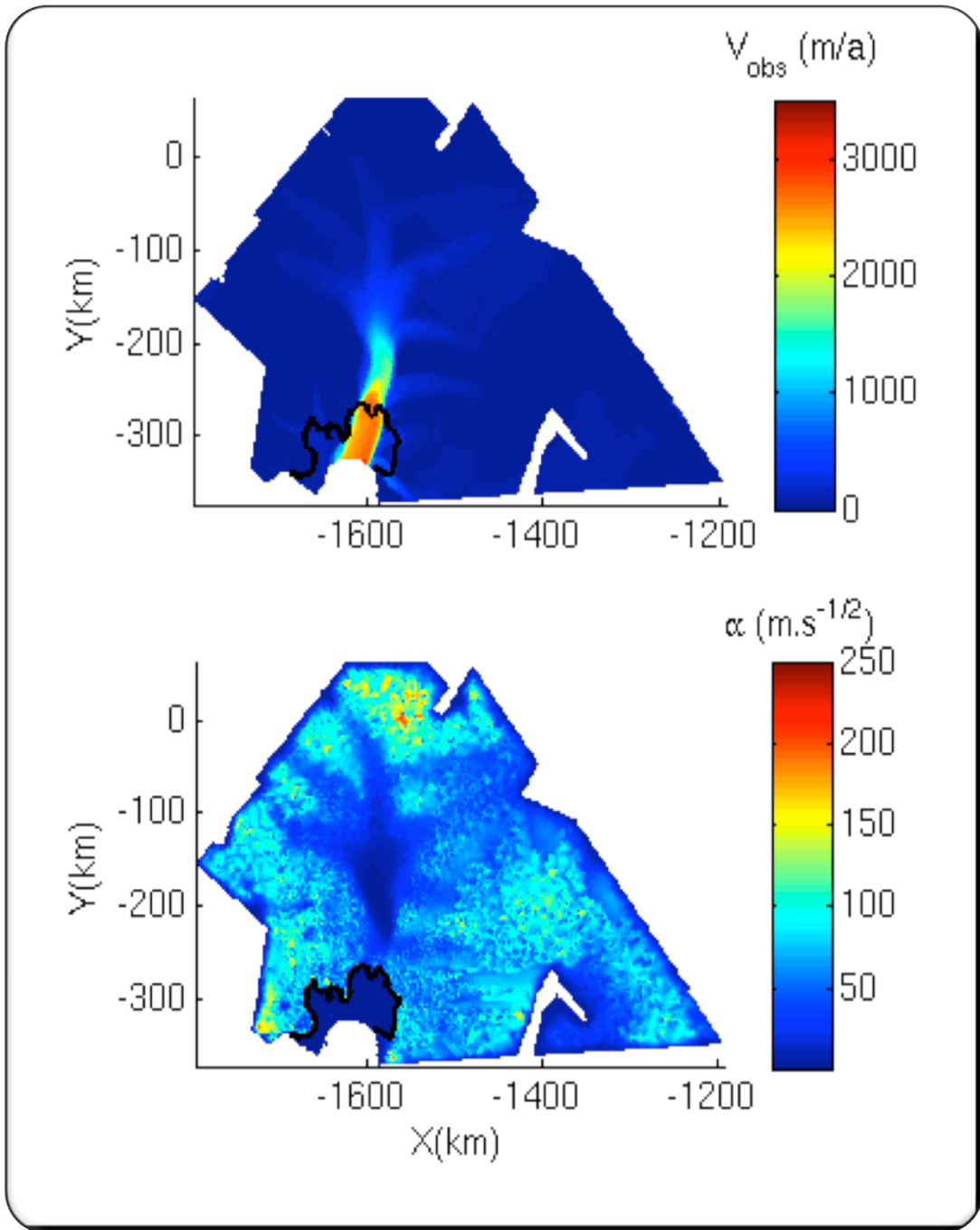
- Offline scripted coupling of ISSM and ECCO2
- Sensitivity analyses on Pine Island Glacier, Antarctica.
- Grounding line migration from 1996 to 2010 integrated within ISSM.
- Melting rate computation for entire Amundsen Sea Embayment
- Constraining of realistic ice sheet flow evolution using realistic melting rates forcing.
- Identification of follow-on issues that need to be solved to fully couple ISSM and ECCO2:
  - Sub-regional modeling for ECCO2 to capture penetration of water under the ice sheet and onset of new cavity formation.
  - Use of EAR-Interim results to best capture wind-regimes that strongly influence distribution of sea-ice in the area.
  - Integration of higher-order grounding-line migration criteria.
  - Coupled data assimilation of thickness and surface velocity data to spin-up transient ice flow models.

## Benefits to NASA and :

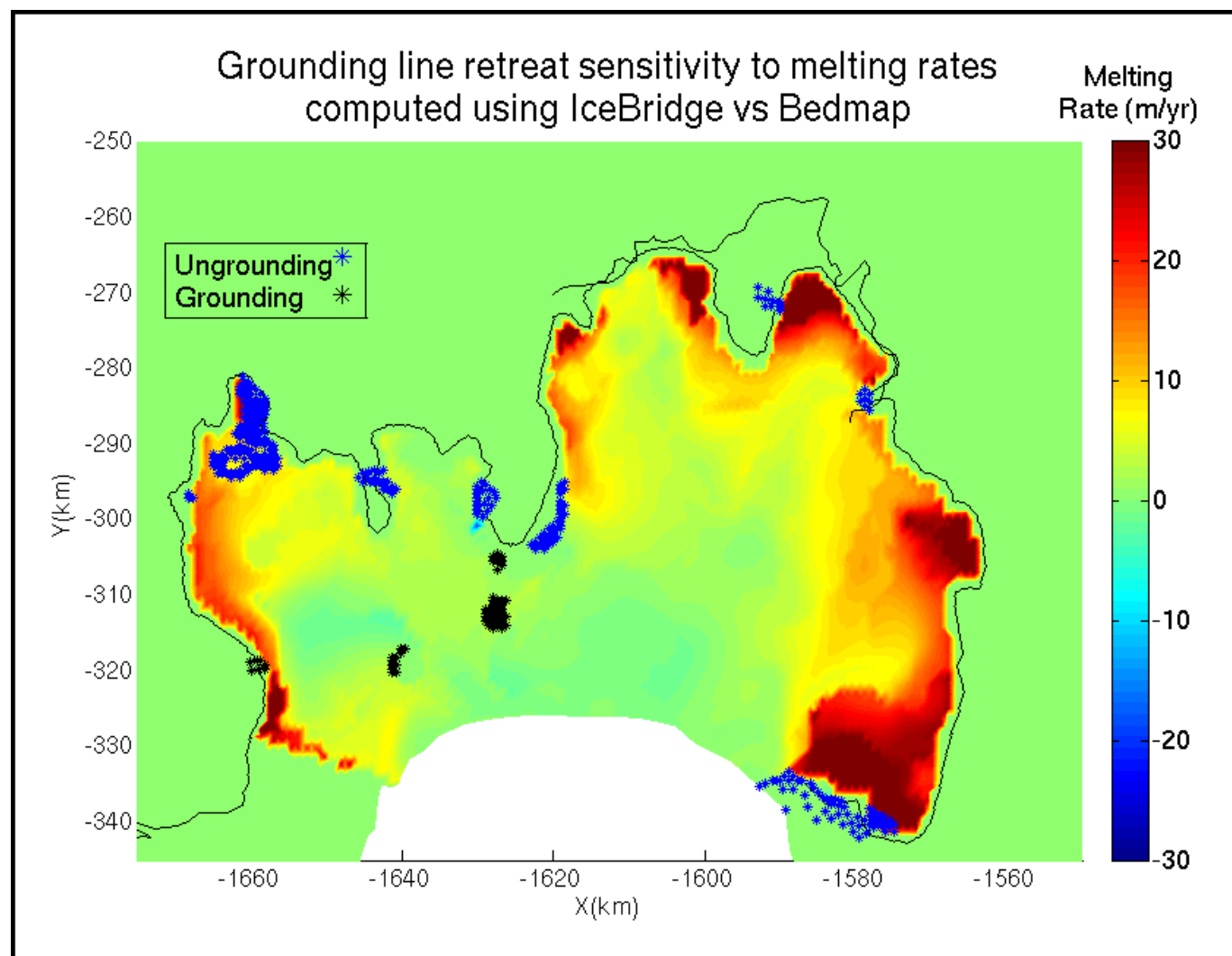
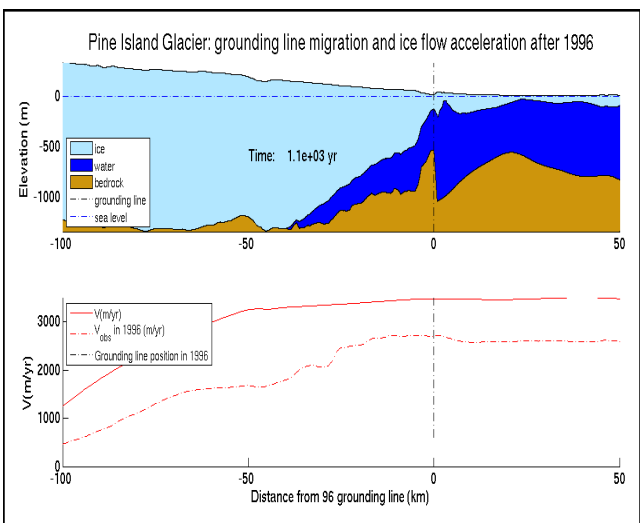
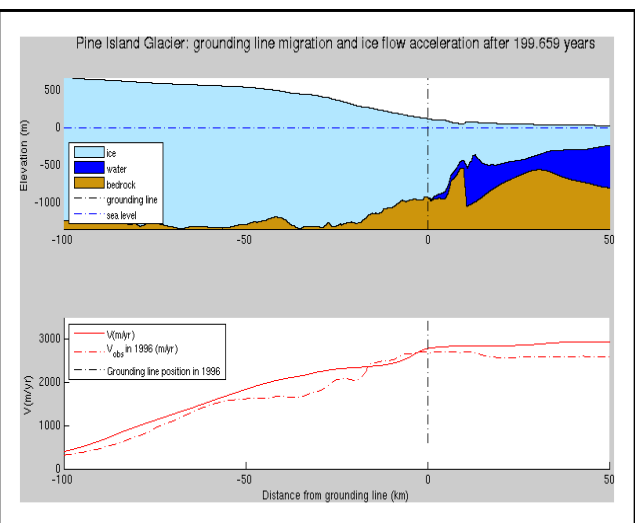
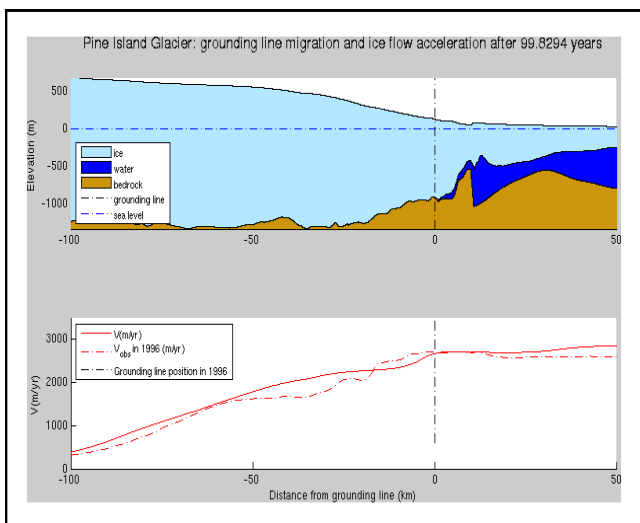
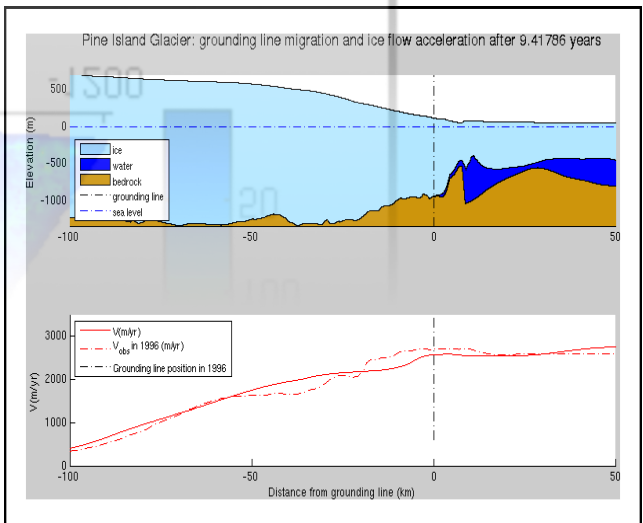
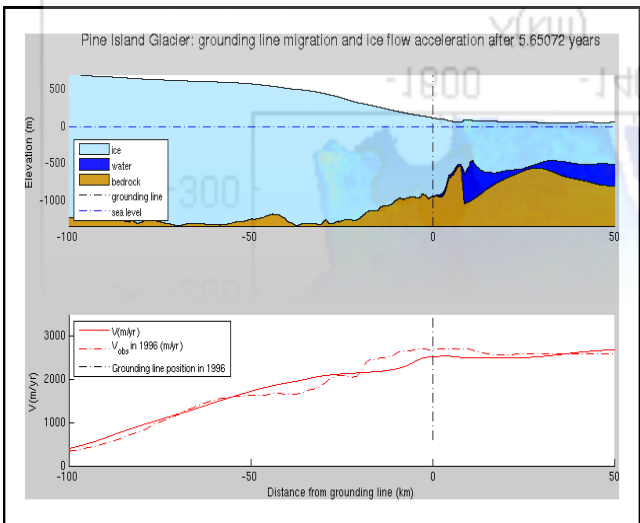
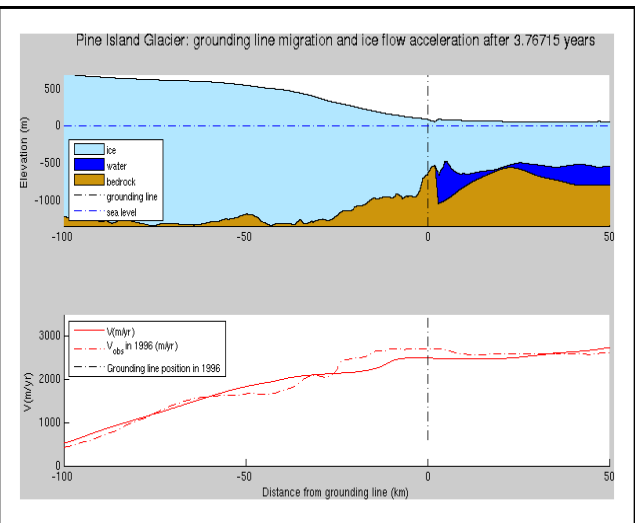
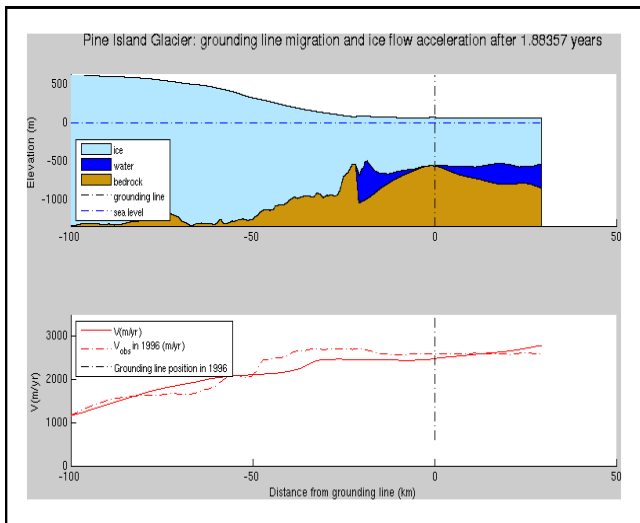
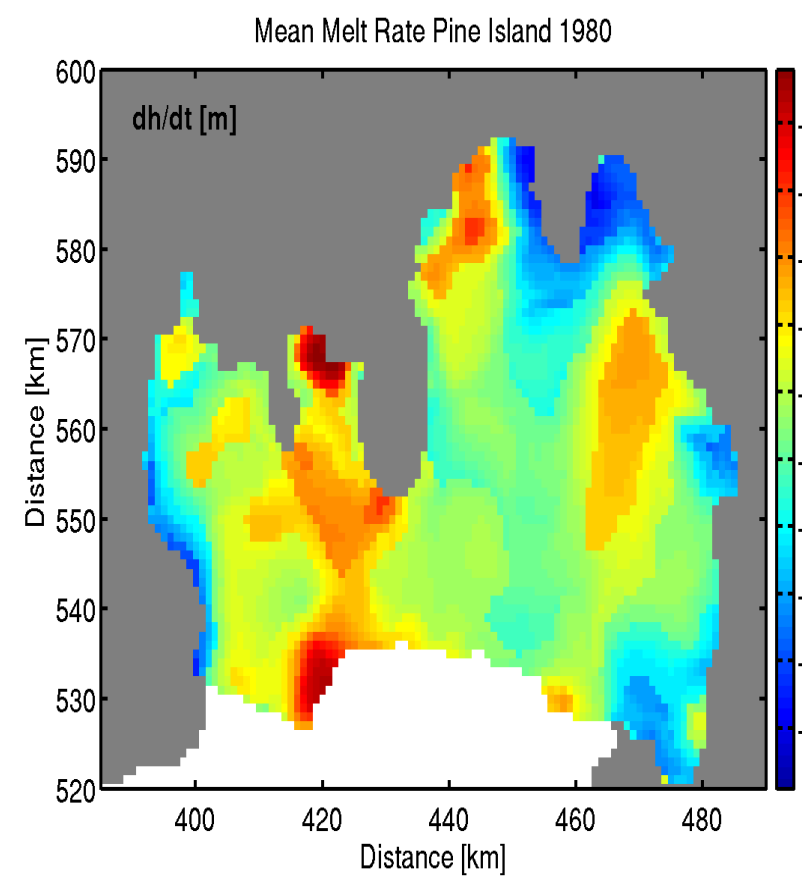
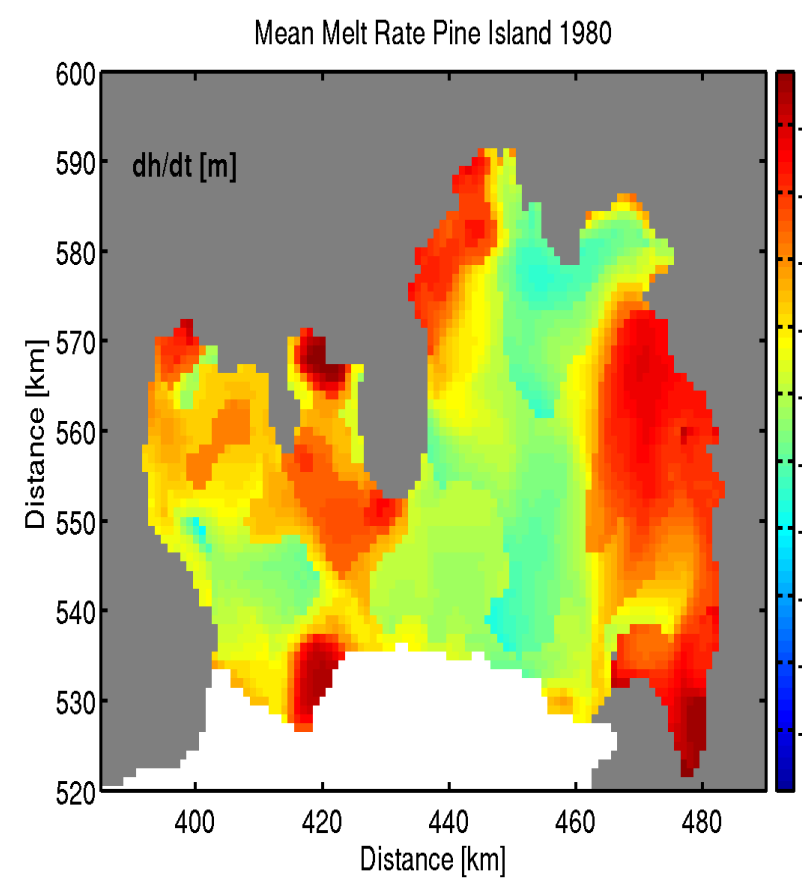
Our effort support ongoing NASA ocean and ice sheet missions (Jason-1, OSTM, QuikSCAT, AMSR-E, GRACE, and ICESAT-1) and international agency missions that provide data to NASA PIs (InSAR data from ERS, ALOS PALSAR, Radarsat-1, Envisat ASAR). The proposed work demonstrates the practical use of data assimilation techniques in coupled ocean and ice sheet modeling, thereby illustrating the usefulness of satellite data to produce better models; it also provides guidance for the derivation of the science requirements of future missions such as GRACE-2, DESDYN-I, SWOT, and ICESAT-2.



- Inverse control methods on basal drag to fit InSAR surface velocities with SSA 2D model (Morlighem 2010)
- Velocity best-fit reaches 10% for overall basin.
- Differences mainly at the grounding line, which will impact the transient response of the glacier.



- Melting rate difference: ~10 m/a.
- Melting rate near grounding line increases.
- Distinction between basins.
- 1992 minimum mainly in northern basin (left)
- Reduced melting from 1995 due to reduced onshore heat transport.



## Publications:

E. Larour, J. Schiermeier, E. Rignot, H. Seroussi, and M. Morlighem, Sensitivity Analysis of Pine Island Glacier ice flow using ISSM and DAKOTA, J. Geophys. Res. (in revision).

E. Larour, H. Seroussi, M. Morlighem, and E. Rignot, Continental scale, high order, high spatial resolution, ice sheet modeling using the Ice Sheet System Model, J. Geophys. Res. (in revision)

E. Larour, et al. Large Scale Inversion of Basal Stress in Greenland using Higher Order and full-Stokes Models (PDF, 3.02 MB). Presented at AGU fall meeting 2010, San Francisco, California, USA, December 13 - 17 2010.

Morlighem, M., E. Rignot, H. Seroussi, E. Larour, H. Ben Dhia, and D. Aubry (2010) Spatial patterns of basal drag inferred using control methods from a full-Stokes and simpler models for Pine Island Glacier, West Antarctica Geophys. Res. Lett., 37, L14502, doi: 10.1029/2010GL043853.